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Biochemical and nutritional properties of baobab pulp from endemic species of Madagascar and the African mainland

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The fruit of baobab (*Adansonia* sp.) is well known in Africa both for its medicinal properties and social uses. It is a very promising tropical fruit although it has been little investigated and exploited in Madagascar. One of the major challenges, in Africa, in the last years has been to establish the baobab as a commercial crop with an economic value. In order to know if Malagasy baobab fruits have the same potential, we proposed to study biochemical characteristics of its fruit pulp. To achieve this objective, five endemic baobab species from Madagascar and one from Côte d'Ivoire were studied. Contents in vitamin C, polyphenols, lipids, proteins and minerals were evaluated. The biochemical composition of the fruit pulp of Madagascar species was studied and compared to that of a Sudano-Sahelian species (*Adansonia digitata*). Results showed high variability in biochemical characteristics and mineral content between the five Malagasy species and the Sudano-Sahelian species. These data revealed that the composition and the interesting nutritional potential of the baobab pulp may be of high interest to Malagasy consumers, which would contribute to rank it as a commercial crop.

Key words: Malagasy baobab, *Adansonia*, biochemical composition, antioxidants activity, species discrimination.

INTRODUCTION

Baobab (*Adansonia*) is a big tree that grows principally in Africa and can live up to 1000 years. It originates from tropical Africa and has a wide distribution range. Baobab species are rustic trees, which are characteristic of Sahelian prairies and Sudano-Sahelian savannas (Wickens and Lowe, 2008) as well as the semiarid tropical zone of the western part of Madagascar. The genus *Adansonia* belongs to the Bombaceae family and the Malvales order. It comprises eight species, six of which are endemic to Madagascar, that is, *A. grandidieri* Baill., *A. madagascarensis* Baill., *A. perrieri* Capuron, *A. fony* var. *rubrostipa* (Jum. & H. Perrier) H. Perrier, *A. suarezensis* H. and *A. za* Baill. *A. gregorii* F. Muell. is exclusively found in Northwestern Australia, whereas *A. digitata* L. is encountered in subtropical Africa where it plays key cultural roles in the beliefs of indigenous people (Kamatou et al., 2011; Sanchez et al., 2010).

The ovoid fruit, called monkey's bread, contains black seeds embedded in a white and chalky pulp. It is consumed as basic food in many regions of Central Africa. For example, the Haoussa ethnic group uses the baobab fruit as the main ingredient in a soup called *miyar*

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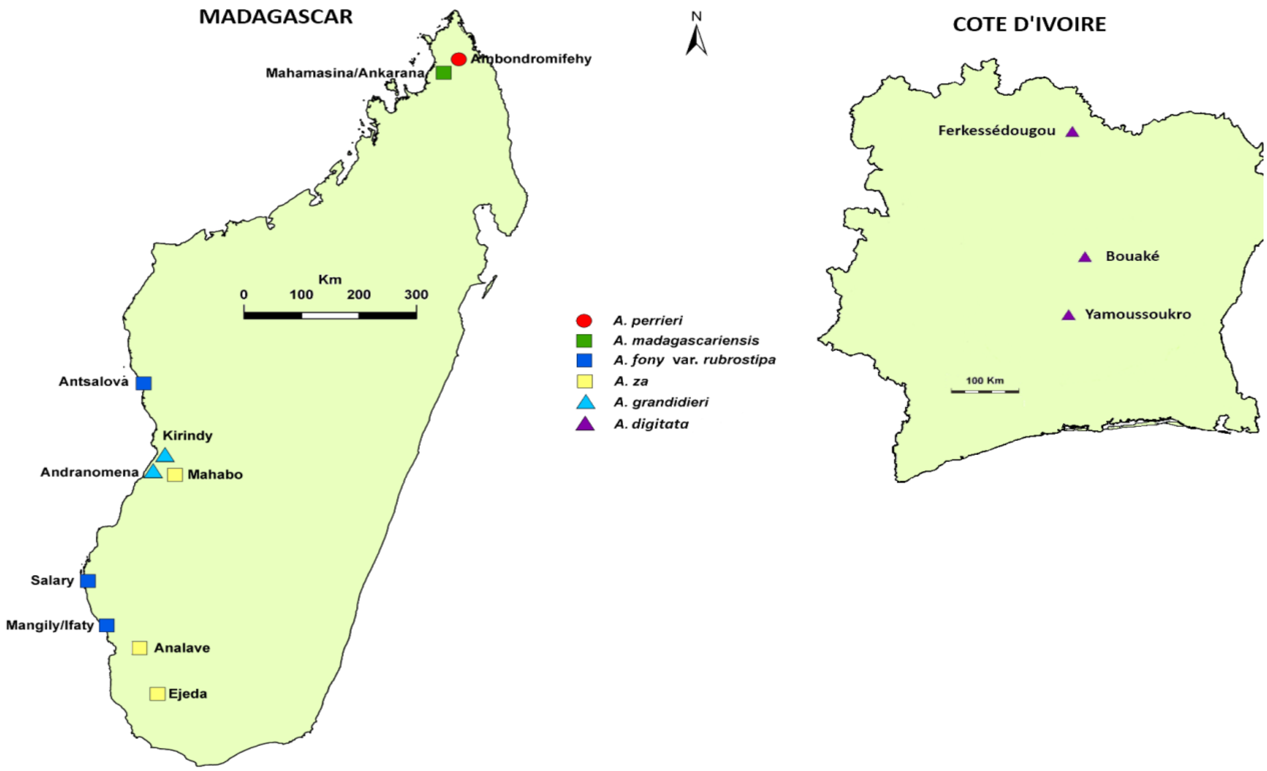

Figure 1. Zones of harvest of the six species of baobab; in Madagascar: *A. perrieri*, *A. Madagascariensis*, *A. fony var. rubrostipa*, *A. Za*, *A. Grandidieri;* in Côte-d'Ivoire : *A digitata.*

kuka. The baobab fruit is also used daily in the diet of rural communities in West Africa (Assogbadjo et al., 2006; Codjia et al., 2001; Sidibé and Williams, 2002). The species contributes to rural incomes (Buchmann et al., 2010; Diop et al., 2005) and has various important medicinal and food uses (Kaboré et al., 2011, Assogbadjo et al., 2006; De Smedt et al., 2010a; 1997; Sena et al., 1998; Sidibé et al., 1996). The pulp is mainly consumed traditionally under different forms. It is used in the formulation and preparation of cereals and beverages.

Although, baobabs are widely known, the current scientific knowledge on the biochemistry and importance of its fruit in human nutrition is scarce. To date, most of the studies have concerned the species *A. digitata* in particular in relation to its botanical (Sena et al., 1998; Soloviev et al., 2004; De Smedt et al., 2010b), agronomical (Munthali et al., 2012; Obizoba and Amaechi, 1993; Codjia et al., 2003; De Caluwé et al., 2009; Wickens and Lowe, 2008) and biochemical characteristics (Parkouda et al., 2012; Chadaré et al., 2009; Diop et al., 2005; Assogbadjo et al., 2005 and 2012; Gebauer et al., 2002; Sidibé and Williams, 2002). Biochemical studies showed that especially the pulp of *A. digitata* is rich in dietary fibers (Chadaré et al., 2009; Cissé et al., 2008), carbohydrates (Solviev et al., 2004; Nour et al., 1980; Murray et al., 2001) and vitamin C (De Caluwé et al., 2010; Chadaré et al., 2009; Sidibé et al., 1996), and that it could be used to produce beverages and nectars (Cissé et al., 2008; Ibiyemi et al., 1988; Obizoba and Anyika, 1994). The current knowledge on the biochemical properties of *A. digitata* is now well known however, these properties are lacking for Malagasy species. Studies have only been carried out on germination (Danthu et al., 1995; Razanameharizaka et al., 2006) and seed fat characterization (Gaydou et al., 1982; Ralaimanarivo et al., 1982).

Our objectives were to improve characterization of the biochemical composition of fruits of various sources, to assess fruit potential for development on a larger scale, and to identify an approach to preserve the pulp so that it may be used in the production of drinks and nectars. We hypothesized that the genetic diversity of endemic Malagasy species evolving in an island ecosystem might show variability in the fruit chemical composition compared to that of Sudano-Sahelian species (*A. digitata*). Therefore, the study aimed to characterize the pulp of Malagasy species and compare it with the African species (*A. digitata*).

MATERIALS AND METHODS

Mature fruits from five species of Malagasy baobabs (*A. za, A. perrieri, A. grandidieri, A. fony* var. *rubrostipa* and

A. madagascariensis) were collected in different geographic zones of Madagascar during the 2009-2010 harvests (Figure 1). Pulps were extracted, vacuum packed, and sent to CIRAD laboratory in Montpellier, France. Mature fruits of *A. digitata* were collected in three geographic zones of Côte d'Ivoire (Figure 1), specifically in Ferkéssédougou (North), Bouake (Center), and Yamoussoukro (South-Center) during two consecutive years (2009-2010). For every species, the samples of pulps resulted from a minimum mixture of six fruits resulting from 2 to 6 trees. Pulps from Malagasy and Ivorian baobab species were ground, sieved through a 0.08 mm sieve, packed into freeze-resistant plastic bags and stored at -80°C until they were analyzed.

Analytical procedures

The moisture content was determined by the gravimetric method at 104°C (Künsch et al., 1999). Total nitrogen content was determined with the Kjeldahl method using 6.25 as the conversion factor of total nitrogen to protein. Lipids were extracted with Avanti Soxtec and petroleum ether as solvent (Anon, 1990). The contents in ashes, carbohydrates, and dietary fibers were determined according to Van Soest et al. (1991).

Pulp nutritive mineral contents (Ca, Na, K, Mg, P) were determined by atomic adsorption spectrophotometry, whereas metals (Fe, Cu, Zn) were determined by flame photometry. The pulp pH was determined at 25°C after dilution at 1/10 (w/v) in deionized water using a pH meter (HANNA, pH 211 Microprocessor). The vitamin C content was determined by oxido-reduction of dichloro-2.6-phenolindophenol (2.6-DCPIP) after extraction with 100/80 (v/v) of metaphosphoric acid/acetic acid. Briefly, 3 g of pulp were homogenized in 30 ml of metaphosphoric acid solution for 30 min under gentle agitation. Samples were filtered using Watman filter paper, and 2 ml of the filtrate were titrated using 2.6-DCPIP until appearance of persistent pink coloration.

The antioxidant capacity was evaluated with the oxygen radical absorbance capacity (ORAC) method (Vaillant et al., 2005). Briefly, an amount of 0.5 g of pulp sample was mixed in 2 ml of a solution of acetone/water (50/50, v/v) for 60 min under gentle shaking at 1900 rpm, and then centrifuged at 14000 rpm at 10°C for 15 min. The supernatant was used in ORAC assays. Total polyphenolic contents were determined with the method described by Georgé et al. (2005). Polyphenols were extracted by mixing 0.3 g of pulp in 10 ml of ethanol/water (70/30 v/v). Extracts were agitated for 10 min using a rotating shaker (Heidolph Multi Reax, Germany) and filtered on Whatman Filter paper. Phenolic compounds were extracted in solid phase in order to reduce interferences associated with other substances such as reducing sugars, alcohols, tartric acid and other antioxidants (such as ascorbic acid) during the polyphenolic determination with the Folin-Ciocalteu reagent. Thus, 2 ml of sample were placed onto an OASIS cartridge column (OASIS simple extraction Product, Ireland), pre-wetted twice with 3 ml of ethanol and rinsed twice with 2 ml of water. The total polyphenolic content was determined by colorimetry using the Folin-Ciocalteu reagent. Gallic acid was used as external standard and the values were expressed as milligrams of polyphenolics per 100 g of sample.

Statistical analysis

In order to ensure reproducibility of the results, all the samples were collected from each species and each sample was analyzed in duplicate. Data were expressed as means, giving the relative standard deviations. The coefficients of variations between years were expressed by standard deviations. Two statistical analyses were performed with Xl-STAT Prov. 7 (Addinsoft): an ANOVA for the year effect, and a principal component analysis (PCA) to detect differences that discriminate the baobab species.

RESULTS AND DISCUSSION

Water contents

Pulp of baobab is a dried pulp. Table 1 shows the biochemical composition of various baobab species. Moisture contents varied among the different species from 11.7 to 13.5% (12.5% on average). For the Malagasy species, the highest content was observed in *A. grandidieri,* whereas *A. fony* var. *rubrostipa* had the lowest. Our results were similar to those reported for *A. digitata* in previous studies (Murray et al., 2001; Soloviev et al., 2004) where average moisture contents were 12%.

Lipids

The lipid contents of different baobab species were very low, varying from 0.5 to 2.1 g lipid / 100 g dry matter (DM) (Table 1). *A. madagascariensis* had the highest lipid content with 2.1 g / 100 g. These values were comparable to those reported by Nour et al. (1980), and Lockett et al. (2000), who observe lipid contents as low as 0.21 and 0.41 g /100 g DM with gravimetric and Soxtec methods, respectively. However, these values are low compared to 15.5 g lipid / 100 DM reported by Glew et al. (1997) for *A. digitata*. This result is very surprising because the lipid content is higher than that found in baobab seeds, that is, 9 g lipid /100 g DM. The Soxtec method used in our study gave 0.94 g /100 g DM of lipid in *A. digitata*, that is, twice the values reported by Lockett et al. (2000) in the same species with the same method. Therefore, the observed variations may result from the analytical methods used, but also from the different baobab ecotypes and species studied.

Proteins

The protein content of the six baobab species varied from 2.5 to 6.3 g protein /100 g DM (Table 1). *A. fony* var. *rubrostipa* had the highest protein content (6.3 g/100 g DM), and *A. za* the lowest (2.5 g/100 g DM). Our results were very similar to those reported by Lockett et al. (2000), and Osman, (2004) who obtain 5.3 g/100 g DM in *A. digitata.* All investigated species, except *A. fony* var. *rubrostipa (*6.3%), had similar protein content. With the same analytical procedures and 6.25 as conversion factor, Chadaré et al. (2009) report a protein content comprised between 2.5 and 17 g/100 DM for *A. digitata.* Only Sena et al. (1998) and Obizoba and Amaechi (1993) report a very high protein contents, 17 and 19.1 g/100 g DM, respectively, but the values were not observed in all other studies realized on *A. digitata*.

Fibers

Fiber content of different baobab species varied from

Table 1. Nutritional composition of six baobab species from Madagascar and Côte d'Ivoire.

Macronutriments	Malagasy Species					African Species		References
	A. za [9]	*A. perrieri [21]*	*A. grandidieri [14]*	*A. fony* var. *rubrostipa [14]*	*A. Madagascariensis [1]*	*A. digitata [9]*	Literature g/100 g	
Moisture g/100 g	13.5	12.8	13.5	11.8	11.7	11.7	11.6	Lockett et al. (2000); Murray et al. (2001); Osman (2004); Soloviev et al. (2004)
Lipids g/100 g	0.5	1.2	1.7	1.6	2.1	0.5	0.2 – 15.5	Lockett et al. (2000); Murray et al. (2001); Osman (2004)
Proteins g/100 g	2.5	3.1	3.5	6.3	3.6	3.0	2.5 – 17	Lockett et al. (2000); Murray et al. (2001); Osman (2004)
Starch g/100 g	38.8	71.7	26.1	43.9	60.8	39.2		
Glucose g/100 g	5.3	2.9	8.9	3.8	2.9	7.9		
Fructose g/100 g	5.4	3.2	9.9	4.1	3.5	7.0		
Sucrose g/100 g	1.04	1.03	5.2	0.6	1.25	1.7		
Fibers g/100 g	25.78	17.20	25.09	27.89	25.82	25.25		
Ash g/100 g	5.3	7.8	6.1	6.9	7.1	5.2	4.9-6.4	Murray et al. (2001)
Acidity meq/100 g	161	132	112	142	95	102	>40	Diop et al. (2005)
Vit. C mg/100 g	138	70	60	92	76	67	300	Gebauer et al. (2002)
Polyphenols mg/100 g	1706	329	600	715	1126	1085	250	Cisse et al. (2008)
Antioxidant capacity µmoles TE/g	151	151	115	159	114	109	25	Besco et al. (2007)

[sample numbers]; TE: Trolox Equivalent.

17.2 to 27.9 g/100 g DM. Excepted *A. perrieri* with 17.2 g/100 g DM, all the species had fiber content around 26 g/100 g DM. Chadaré et al. (2009) note variability between 0.6 and 45.1 g/100 g DM. In fact, this variability could be explained by the method used. The average value observed by these authors is 13.7 g/100 g DM.

Carbohydrates

As in most fruits, in two studied species (*A. perrieri* and *A madagascariensis*), carbohydrates represented more than 60% of the dry matter and consisted of soluble sugars for half of it. In baobab fruits, among the soluble sugars, glucose was the least represented, but the content of reducing sugars (glucose + fructose) was greater than the sucrose content. Results showed variability in carbohydrate contents, especially for starch, as two species, *A. perrieri* and *A. madagascariensis,* had high values, 71.7 and 60.8 % DM, respectively, compared to the others, from 26.1 to 43.9 %. The highest sugar contents were found in *A. grandidieri* with 8.9% for glucose, 9.9% for fructose and 5.2% for sucrose, followed by *A. digitata* with 7.9% for glucose, 7.0% for fructose and 1.70% for sucrose (Table 1). We thus observed that the species with the highest starch contents had the lowest free sugar contents. The presence of sugar was similar to that mentioned by Soloviev et al. (2004), who found a total of soluble sugar content ranging between 7.2 and 11.2 g/100 g DM in the pulp of baobab, whereas Nour et al. (1980) report a 23.2% total sugars and 19.9% reducing sugars. According to Murray et al. (2001), simple sugars represent about 35.6% of total carbohydrates. This explains the considerably sweet taste of the pulp. However, sweetness can vary depending on the species, maturity of the fruits, and environmental soil and climate.

Acidity

Very high acidity was observed in the pulp of all investigated species (Table 1). The highest value was 161 meq/100 g MS in *A. za*. Among the studied parameters, acidity and ascorbic acid contents showed the highest variations between samples. Pedoclimatic conditions and storage conditions of the pulp were among factors that might explain such variations.

Ash

Ash contents were 7.8 g/100 g DM in *A. perrieri* (the highest value) and 5.3 g/100 g DM in *A. za* (the lowest value). These results were similar to those of Murray et al. (2001), and Lockett et al. (2000) who report a content of 5.1 to 5.7 g/100 gDM, respectively, whereas a very low value of 2.4 g/100 g DM is reported in Obizoba and Amaechi (1993). The incidence of soil and climatic conditions, and ripeness stage at harvest were factors that could explain these variations.

Vitamin C

Table 1 shows the vitamin C content of the six baobab species, which was comprised between 60 and 138 mg/100 g DM. *A. za* had the highest vitamin C content, whereas that of *A. grandidieri* was twice as low. These data clearly showed the high variability of vitamin C content between species that are endemic to Madagascar. This variability existed also between regions in Sudano-Sahelian species *A. digitata* (Data not shown). Indeed, besides the variability between species observed in our data, Scheuring et al. (1999) also reports a high variability between trees of the same species. Our study showed that the vitamin C content of baobab pulp (60-138 mg/100 g) was similar to that of kiwi fruits (98-180 mg/100 g), higher than that of oranges (37-92 mg/100 g) and papayas (62 mg/100 g) (Rodrigues et al., 2001), but lower than that of jujubes (500 mg/100 g). Nonetheless, our values for the genus *Adansonia* were lower than those of 300 mg vitamin C /100 g DM in *A. digitata* reported by Gebauer et al. (2002).

Polyphenols

As with vitamin C and proteins, the polyphenolic content of the six baobab species showed high variability among species (Table 1). *A. perrieri* had the lowest polyphenolic content (329 mg/100 g), whereas *A. za* had the highest (1706 mg/100 g). Table 1 shows that *A. za, A. digitata* and *A. madagascariensis* can be considered as the ones producing fruits with high polyphenolic contents. Lamien-Meda et al. (2008) also report high polyphenol content in *A. digitata,* in relation to 13 other fruits of Burkina Faso.

Antioxidant capacity

The ORAC method was used to evaluate the antioxidant capacity of the pulp samples collected from Malagasy baobab species and the African mainland species, *A. digitata*. The antioxidant capacities of the fruit pulp from the six species were comprised between 109 and 159 µmol TE/g. All Malagasy species had higher antioxidant capacity than *A. digitata.* Consumption of foods rich in antioxidant is highly recommended as a factor contributing to the prevention and reduction of human cell death caused by oxidation, and thus reducing the incidence of some diseases. The baobab high antioxidant capacity could contribute to increase its economic value. Its antioxidant capacity was higher than many widely consumed fruits and vegetables. Indeed *A. digitata* had 108 µmol TE/g DM antioxidant capacity. For comparison, oranges have 100 µmoles TE/mg, kiwis 340 µmoles TE/mg (Vertuani et al., 2002), strawberries 15 µmoles TE/mg, lentils 81 µmol TE/g, grapes 87 µmol TE/g, blackberries 72 µmol TE/g and tomatoes 67 µmol TE/g, and these products are well known for their high antioxidant capacity (Lam et al., 2005).

Minerals and metals

The mineral composition of juices and fruits are among the criteria that guide consumers' choice. Among the minerals analyzed (Table 2) in this study, the K content was higher than 1528 mg/100 g DM in all six species indicating that K was the most predominant mineral, and A. za had the highest K content (3054 mg/100 g). The baobab fruit thus ranks among species with a very high source of K. The content of P and Na varied from 57 to 116 mg/100 g DM and 2.3 to 43.4 mg/100 g DM, respectively. Ca and Mg are major minerals in human nutrition, and their levels were comprised between 313 and 658 mg/100 g DM for Ca, and 176 and 255 mg/100 g DM for Mg. Therefore, the baobab pulp might be an important source of Ca, higher than that of milk. The Mg content was also high and similar to those found in almonds and hazelnuts (USDA, 2011a). Na and Fe are also important in biological systems, mainly as electrolytes and as heme for Fe in blood cells; their levels ranged between 0 and 40 mg/100 g DM, and 49 and 202 ppm, respectively. Arnold et al. (1985), and Osman (2004) reported a high variation in the Fe content of *A. Digitata*, 1.1 and 10.4 mg/100 g DM, respectively.

The high variability in mineral and metal contents in the baobab pulp has been largely highlighted (Nour et al., 1980; Arnold et al., 1985; Sena et al., 1998; Osman, 2004). It may be associated, at least in part, with the soil type and origin of samples.

Potential impact on daily intake

For 4-to-8-year old children, the recommended daily intake (RDI) is 0.025 g/100 g vitamin C, 0.8 g/100 g Ca,

Table 2. Mineral composition of pulp from six baobab species from Madagascar and Côte d'Ivoire.

Minerals (mg/100 g)	Malagasy species				African species			
	A. za [9]	*A. perrieri* [20]	*A. grandidieri* [14]	*A. fony var. rubrostipa* [13]	*A. madagascariensis* [1]	*A. digitata* [3]	Literature mg/100 g	References
P	57	116	72	94	80	80	106	Obizoba and Amaechi (1993); Saka and Msonthi ,(1994); Glew et al. (1997); Sena et al. (1998)
K	3054	2728	2221	2735	2252	1528	1794	Saka and Msonthi (1994); Sena et al. (1998); Osman (2004)
Ca	464	658	356	313	372	345	302	Sena et al. (1998); Lockett et al. (2000); Osman (2004)
Mg	255	224	176	198	225	199	195	Glew et al. (1997); Sena et al. (1998); Lockett et al. (2000); Osman (2004)
Na	9.0	5.9	8.9	43.4	5.7	2.3	14.8	Glew et al. (1997); Sena et al. (1998); Osman (2004)
Cu	0.7	0.3	0.8	0.5	0.9	1.5	0.9	Obizoba and Amaechi (1993); Sena et al. (1998); Lockett et al. (2000); Osman (2004)
Fe	10.5	9.2	16.6	10.6	4.9	10.0	4.3	Arnold et al. (1985); Obizoba and Amaechi (1993);
Mn	1.4	0.70	1.4	2.2	0.6	2.1	0.7	Saka and Msonthi (1994); Glew et al. (1997); Sena et al. (1998); Lockett et al. (2000); Osman (2004)

[sample numbers].

0.01 g/100 g Fe, and 19 g/100 g proteins (USDA 2011b). The same authors recommend 0.085 g/100 g, 1g/100 g, 0.027 g/100 g, and 71 g/100 g of vitamin C, Ca, Fe, and proteins, respectively, for 19-to-30-year-old pregnant women. Thus, consumption of 40 g of pulp of *A. digitata* (the richest species in vitamin C) and *A. za* (the poorest) by a child aged 4-8 years covers 220 and 96% vitamin C RDI, respectively. For pregnant women aged 19-30 years, the consumption of 40 g of baobab pulp covers from 30 to 60% of RDI depending on the species (Table 3). The calcium, protein and iron values found in our species (Table 3) were similar to those observed by Chadaré et al. (2009) for *A. Digitata*. The highest values reported by these authors show that the consumption of 40 g of baobab pulp covers the following RDIs: 41.5% of Fe, 25.4% of zinc, and 35% of calcium for children aged 4 to 8 years. The consumption of 40 g of pulp by a pregnant woman covers from 84 to 141% of RDI of vitamin C, considering the lowest and highest vitamin C contents of the pulp reported by Chadaré et al. (2009). The baobab pulp is undoubtedly a valuable source of vitamin C.

Discrimination of baobab species

A principal component analysis (PCA) was performed on all biochemical data measured on the six species. The first three main axes explained 40.18, 22.46 and 16.44%, respectively, of the total variance. Figure 2 shows the circles of correlation of plans 1-2 and 1-3 and species representation on these plans. *A. za* is clearly separated from the others, *A. digitata* and *A. grandidieri* form a second group, which is distinct from other species. A third group consists of three Malagasy species, *A. fony* var. *rubrostipa, A. perrieri* and *A. madagascariensis*.

The species of this group are clearly separated in the graphical representation of plan 1-3. Glucose, fructose, sucrose, Ca and K variables were positively correlated, and starch and

Table 3. Recommended daily intake (RDI) for children (aged 4-8 years) and pregnant women (aged 19-30 years).

Macronutriments	Subject	Need/day	*A.za* (40 g)	*A. perrieri* (40 g)	*A. grandidieri* (40 g)	*A. fony* var. *rubrostipa* (40 g)	A. madagascariensis (40 g)	*A. digitata* (40 g)
			(%) Supply	(%) Supply	(%) Supply	(%) Supply	(%) Supply	(%) Supply
Vitamin C	Children 4-8 years	0.025	220	113	96	148	122	107
	Women 19-30 years	0.085	65	33	28	43	36	32
Ca	Children 4-8 years	0.8	23	33	16	16	19	17
	Women 19-30 years	1	18	26	13	12	15	14
Proteins	Children 4-8 years	19	5	7	7	13	8	6
	Women 19-30 years	71	1	2	2	4	2	2
Fe	Children 4-8 years	0.01	42	37	81	42	20	40
	Women 19-30 years	0.027	16	14	30	16	7	15

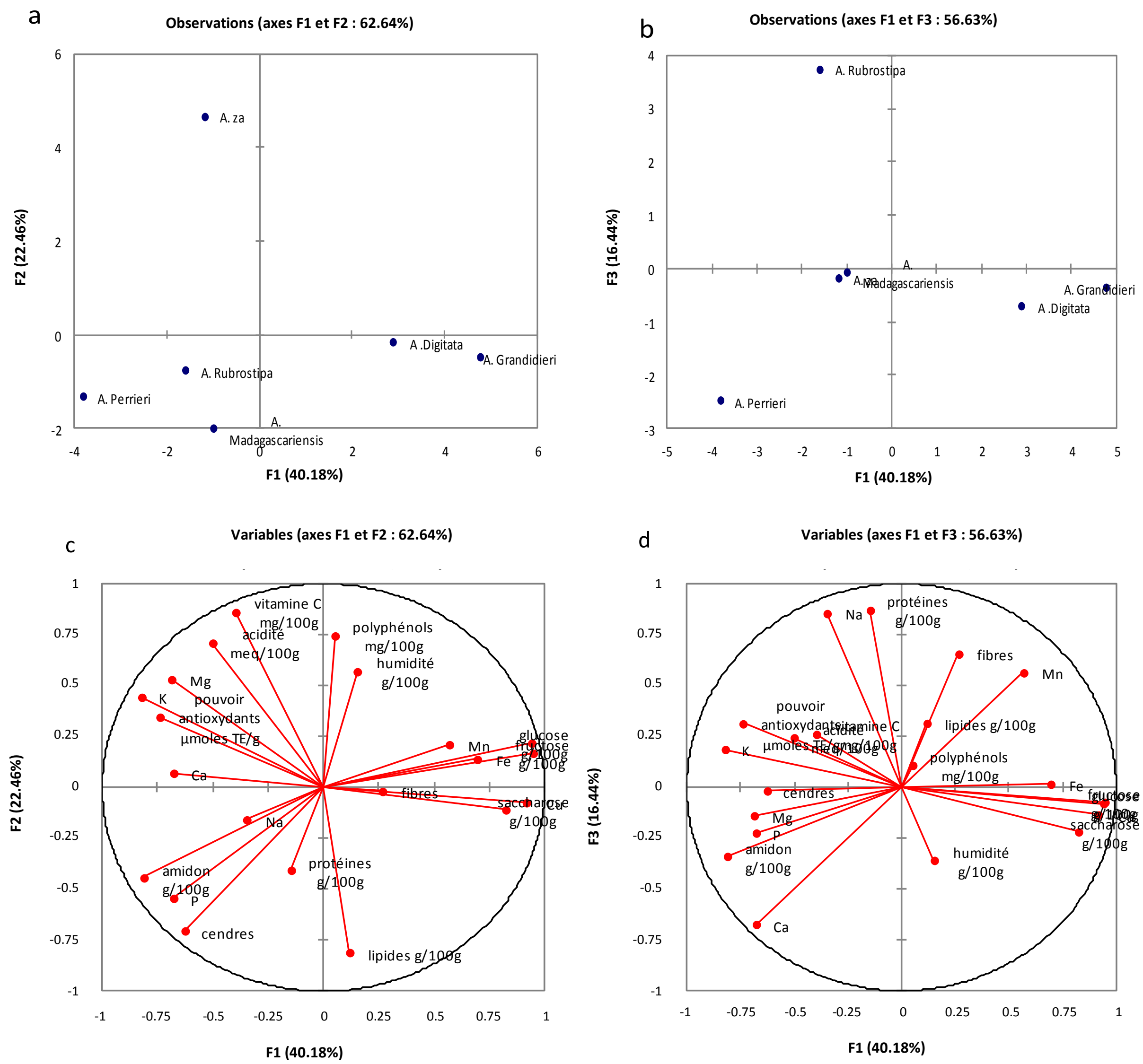

Figure 2. Biplot of baobab species loadings (a and b) and variable scores (c and d) on the first three axes of the PCA.

antioxidant capacity negatively (Figure 2). Vitamin C and polyphenol variables were positively correlated to axis 2, and lipids and ash negatively. Variables proteins and Na were positively correlated to axis 3, and Ca was negatively correlated. *A. za* was characterized by a high content of vitamin C and a low fat content. *A. digitata* and *A. grandidieri* were characterized by low levels of sugar (glucose, fructose, sucrose) and Ca. *A. fony* var. *rubrostipa, A. perrieri,* and *A. madagascariensis* were characterized by higher starch, ash and fat contents than those in other species (plan 1-2). The protein content and Na were highest (plan 1-3) in *A. fony* var. *rubrostipa*, whereas *A. perrieri* was characterized by its Ca content.

Conclusion

This study showed a high variation in the biochemical, mineral and nutritional characteristics of five endemic species of Madagascar and one African Sudano-Sahelian species, *A. digitata*. All investigated species showed higher vitamin C and mineral contents, and stronger antioxidant capacity than commonly consumed fruits. Because of its biochemical and nutritional characteristics, the baobab pulp is quantitatively and qualitatively nutritive, and suitable for marketing on a large scale. To increase the added-value of the baobab product, efficient processing methods to preserve pulp quality during storage or transformation are necessary. To date, despite the baobab fruit nutritional importance, the lack of knowledge on pulp preservation causes loss. Future research should focus on increasing the pulp storage time while preserving its nutritive and sensorial value, and ensure its stability.

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